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REMARKS

Claims 13 and 45 have been amended to correct typographical errors. Claim 46 has been amended to more clearly define Applicants' invention. Support can be found, for example, at page 6, lines 15 to 17 and Figure 4 of the specification. No new matter has been added. Claims 1 to 65 are pending. Claims 1, 21, 29, 44, 45, 46, and 52 are independent.

Applicants thank the Examiner for indicating allowability of claims 8, 13-17, 26, 27, 32, 37-42, 47-51, 57, 59-64, 45 and 44. See pages 7 and 8 of the Office Action.

1449

The Examiner indicated at page 3 of the Office Action that reference "AR" has not been considered because "it lacks pertinent information such as date of application." See page 3 of the Office Action.

Applicants include two attachments: a previously submitted PTO-1449 at Tab A that has been modified to include a publication date and dated document ("document") at Tab B. Based on our understanding and inspection of the document, Applicants believe that the reference AR was publicly available on March 27, 2000.

Objections

The Examiner has objected to claims 13 and 45. See page 3 of the Office Action. Claim 13 has been amended to include the proper antecedent basis. Claim 45 has been amended to delete the second "the". Applicants respectfully request reconsideration and withdrawal of these objections.

Rejection under 35 U.S.C. § 102(e)

Claim 46 has been rejected under 35 U.S.C. § 102(e) as being anticipated by U. S. Patent No. 6,109,737 to Kishima *et al.* ("Kishima"). See page 4 of the Office Action. Claim 46 is independent.

In making the rejection, the Examiner asserts that:

> Kishima discloses all the claimed features of the invention including:
> -a method of manufacturing an ink jet printing module comprising:
> -contacting a first component (32) of an ink jet printing module (19) having a surface with a thermoplastic bonding component (50);
> -contacting a second component (31) of the ink jet printing module including a orifice plate (30) having a surface with the thermoplastic bonding component (Fig. 3);
> -adhering a peelable protector strip (251) over the orifice plate (column 8, lines 6-10). (See page 4 of the Office Action).

Applicants have discovered a method of manufacturing an ink jet module including adhering a peelable protector strip over an orifice of the orifice plate. See amended independent claim 46. In Kishima, **251** is a liquid repelling film not a peelable protector film as described in amended claim 46. Specifically, Kishima describes a liquid repelling film **251** which "repels ink, [sic] is formed to prevent ink from adhering <u>around</u> a nozzle." See Kishima at col. 35, lines 56 to 57 (emphasis added) and Figure 25. Indeed, in Kishima, the liquid repelling film does not adhere over an orifice of the orifice plate. See Figure 25 of Kishima. Kishima further describes that "a liquid repelling film provided with heat resistance and resistance to peeling." See Kishima at col. 8, lines 6 to 7. A liquid repelling film which resists peeling is not a a peelable protector strip. Thus, Kishima does not describe adhering a peelable protector strip over an orifice of the orifice plate of an ink jet module. Accordingly, independent claim 46 is not anticipated by Kishima. Applicants respectfully request reconsideration and withdrawal of this rejection.

<u>Rejection under 35 U.S.C. § 102(e)</u>

Claims 1-6, 9, 10, 12, 21-25, 29, 30, 33, 34, 36, 52, 53, 55, and 58 have been rejected under 35 U.S.C. § 102(e) as being anticipated by U. S. Patent No. 6,361,146 to Singh *et al.* ("Singh"). See page 4 of the Office Action. Claim 1, 21, 29 and 52 are independent.

The Examiner asserts that Singh discloses the following claim limitations, among others:

> -contacting a first component (48) of an ink jet printing module (Fig. 3) having a surface with a thermoplastic bonding component (5), the thermoplastic bonding component having dimensions of a surface of the first component (Fig. 3);
> -heating the surface to bond the surface to the thermoplastic bonding component (column 6, lines 43-50); ...

> -a second component (20) of the ink jet printing module having a surface with the thermoplastic bonding component;
> -heating the surface to bond the surface to the thermoplastic bonding component (column , lines 43-45). (See pages 4 to 5 of the Office Action).

Applicants have discovered an ink jet module and method of manufacturing an ink jet module. See independent claims 1, 21, 29 and 52. The ink jet module and method includes contacting a component with a <u>thermoplastic</u> bonding component. See independent claims 1, 21, 29 and 52. Singh does not describe a <u>thermoplastic</u> bonding component. See independent claims 1, 21, 29 and 52. Specifically, Singh discloses "[a]dhesive bond as used herein refers to a non-releasable, non-repositionable adhesive bond, unlike the releasable, repositionable adhesive bonds similar to those used as adhesives in self-stick removable note pads, and the like." See Singh at col. 3, lines 4 to 8. Moreover, Singh discloses "a first adhesive film that is capable of adhesively bonding to an epoxy coating and a second adhesive film that is capable of adhesively bonding to a stainless steel substrate." See Singh at col. 2, lines 62 to 65. In Singh, the films are adhesive layers. In independent claims 1, 21, 29 and 52, the component is contacted with a <u>thermoplastic</u> bonding component. An adhesive film is not a thermoplastic bonding component, as claimed in Applicants' invention.

For at least these reasons, independent claims 1, 21, 29 and 52 and claims that depend therefrom are not anticipated by Singh. Applicants respectfully request reconsideration and withdrawal of this rejection.

<u>Rejection under 35 U.S.C. § 103(a)</u>

Claims 11, 35, and 54 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Singh. See page 4 of the Office Action. Claims 11, 35 and 54 depend from independent claims 1, 29 and 52.

In making the rejection, the Examiner asserts that:

> it would have been obvious to a person having ordinary skill in the art at the time the invention was made to modify the thickness of thermoplastic bonding component of Singh et al. to that as claimed for the purpose of preference for use in ink jet assemblies. (See page 6 of the Office Action).

Independent claims 1 and 29 and claims that depend therefrom

As discussed above, Singh does not teach or suggest a thermoplastic bonding layer. Indeed, Singh merely describes adhesive films. A person of ordinary skill in the art would not be motivated by Singh to contact a component with a thermoplastic bonding component because adhering with an adhesive is not contacting a component with a thermoplastic layer. See adhesive bond definition in Singh. Thus, without the benefit of Applicants' invention, one of ordinary skill in the art would not arrive at a thermoplastic bonding component.

For at least these reasons, independent claims 1 and 29 and claims that depend therefrom are not obvious over Singh.

Independent claim 52 and claims that depend therefrom

Applicants have discovered an ink jet printing module which includes a piezoelectric element including a surface and a thermoplastic bonding component heat-bonded to the surface. See independent claim 52. Singh does not teach or suggest a thermoplastic bonding component heat-bonded to the surface of a piezoelectric element. As discussed above, Singh merely describes bonding with adhesive films not a thermoplastic bonding component. There is no suggestion in Singh that would one motivate one of ordinary skill in the art to contact a piezoelectric element surface with a thermoplastic bonding component much less to heat-bond a surface with a thermoplastic bonding component. The Examiner has not presented a *prima facie* case of obviousness.

For at least these reasons, independent claims 1, 29 and 52 and claims that depend therefrom are patentable over Singh. Applicants respectfully request reconsideration and withdrawal of this rejection.

Rejection under 35 U.S.C. § 103(a)

Claims 7, 18-20, 28, 31, 43, 56, and 65 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Singh combined with Kishima. See page 6 of the Office Action. Claims 7, 18 to 20, 28, 31, 43, 56 and 65 depend from independent claims 1, 21, 29 and 52.

In making the rejection, the Examiner asserts that:

> [i]t would have been obvious to a person having ordinary skill in the art at the time the invention was made to provide Singh et al. with the thermoplastic

> bonding component including an electrode pattern and a protector strip adhered over the orifice plate as disclosed by Kishima for the purposes of bonding and deforming a piezoelectric element and repelling ink. (See page 7 of the Office Action).

<u>Independent claims 1, 21 and 29 and claims that depend therefrom</u>

Kishima does not teach or suggest a thermoplastic bonding layer having the dimensions of a first component. See independent claims 1, 21, and 29. Instead, Kishima teaches that "the metallic layer **62** is formed by copper, the above protruding pattern **51** and pattern layer **52** can be formed using dry film resist, using the aqueous solution of ferric chloride." See Kishima at Figure 6(A) and (B) and col. 18, lines 55 to 57. In Kishima, a metallic layer is etched over component 50. In independent claims 1, 21 and 29, the thermoplastic bonding layer itself has dimensions of the first component. See, for example, Figure 4 of the specification. A laminated metallic pattern over a thermoplastic layer is not thermoplastic bonding layer having the dimensions of a first component.

As discussed above, Singh does not teach or suggest a thermoplastic bonding layer. Thus, neither Singh nor Kishima, nor their combination, provide any motivation to contact a component with a thermoplastic bonding component, the thermoplastic bonding component having dimensions of a surface of the first component. For at least these reasons, independent claims 1, 21, and 29 and claims that depend therefrom are patentable over Singh combined with Kishima.

<u>Independent claim 52 and claims that depend therefrom</u>

Kishima does not teach or suggest a thermoplastic bonding component heat-bonded to a surface. In Kishima the

> plural protruding portions **51** are laminated on one main surface **50A** of a thermoplastic layer **50** formed by thermoplastic material amd provided with an adhesive property and the above thermoplastic layer **50** is bonded onto main surface **31A**. (See Kishima at col. 16, lines 26 to 31)

Indeed, in Kishima, layer 50 is adhered by an adhesive. Kishima does not teach a thermoplastic bonding component heat-bonded to a surface. As discussed above, Singh does not teach heat-

bonding a thermoplastic bonding component to the surface of piezoelectric element. Adhering with an adhesive is not heat-bonding a thermoplastic layer. Thus, neither Singh nor Kishima, nor their combination, provide any motivation to contact a thermoplastic bonding component to heat-bonded the thermoplastic bonding component to the surface of a component.

For at least these reasons, independent claims 1, 21, 29 and 52 and claims that depend therefrom are patentable over Singh combined with Kishima. Applicants respectfully request reconsideration and withdrawal of this rejection.

CONCLUSION

Applicants ask that all the claims be allowed.

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Substitute Form PTO-1449 (Modifi d) U.S. Department of Commerce Patent and Trad mark Office	Attorney's Docket No. 09991-014001	Application No. 09/749,893
Informati n Discl sure Statement by Applicant (Use sev ral sh ets if n cessary)	Applicant Robert PALIFKA et al.	
(37 CFR §1.98(b))	Filing Date December 29, 2000	Group Art Unit

U.S. Patent Documents

Examiner Initial	Desig. ID	Patent Number	Issue Date	Patentee	Class	Subclass	Filing Date If Appropriate
Um	AA	6,147,438	11/14/00	Nishiwaki et al.	310	363	
	AB	6,143,399	11/07/00	Kohno et al.	428	220	
	AC	6,136,915	10/24/00	Ohara et al.	524	538	
	AD	6,129,982	10/10/00	Yamaguchi et al.	428	336	
	AE	6,109,737	08/29/00	Kishima	347	70	
	AF	6,106,096	08/22/00	Komplin et al.	347	20	
	AG	6,037,707	03/14/00	Gailus et al.	310	363	
	AH	5,945,253	08/31/99	Narang et al.	430	280.1	
	AI	5,891,986	04/06/99	Yamaguchi et al.	528	310	
	AJ	5,849,397	12/15/98	Kohno et al.	428	209	
	AK	5,830,564	11/03/98	Kohno et al.	428	220	
	AL	5,728,473	03/17/98	Inoue et al.	428	440	
Um	AM	5,434,607	07/18/95	Keefe	347	50	

Foreign Patent Documents or Published Foreign Patent Applications

Examiner Initial	Desig. ID	Document Number	Publication Date	Country or Patent Office	Class	Subclass	Translation Yes	Translation No
Um	AN	EP 1 018 507	07/12//00	EPO	—	—		
	AO	EP 1 018 534	07/12//00	EPO	—	—		
	AP	EP 0 786 348	07/30/97	EPO	—	—		
Um	AQ	EP 0 624 472	07/23/97	EPO	—	—		

Other Documents (include Author, Title, Date, and Place of Publication)

Examiner Initial	Desig. ID	Document
Am	AR	UBE Industries, LTD., (Brochure) "Development of Heat Bonding Type Polyimide Film Upilex VT", Japan, ~~Date Unknown~~ 3/27/2000
	AS	
	AT	
	AU	

Examiner Signature	Date Considered
[signature]	7/17/03

EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Development of Heat Bonding Type

Polyimide Film

UPILEX® VT

UBE INDUSTRIES, LTD.

Specialty Products Div. Business Development Dept.

Ube Building, 2-3-11, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140, Japan

Phone (03) 5460-3242

Facsimile (03) 5460-3406

<URL> http://www.ube-ind.co.jp

Development of Heat Bonding Type Polyimide Film 「UPILEX.VT」

Specialty Products Div. Business Development Dept.
TAKUHIRO ISHII E-Mail:28369u@ube-ind.co.jp

1.Introduction

Polyimide film is a high heat-resistant insulating material.
The demand of the polyimide film expands around electric and electronic industrial field.
Ube Industries, Ltd. has an industrial synthetic technology of BPDA(biphenyltetracarboxylic dianhydride) by the coupling reaction of the aromatic group.
The polyimide is obtained by the polymerization of BPDA and the aromatic group diamine in the polar solvent, then the polyimide film is made by the casting method.
The representative grade of the BPDA type polyimide film is 「UPILEX-S」.
「UPILEX-S」 has a high market share as a base film for TAB(Tape Automated Bonding) with excellent heat-resistance, mechanical strength, and the dimension stability, etc.
Ube Industries, Ltd. developed new polyimide film 「UPILEX VT」 with the excellent heat bonding characteristics based on this BPDA type polyimide technology.
Thanks to「UPILEX VT」's excellent bonding properties without using adhesive, there are wide range of possibility of applications.
In this text, 「UPILEX VT」 made by the continuous film casting equipment is introduced together with the data .

2.Characteristic

There is a base film for FPC(Flexible Print Circuit) in a typical usage of the polyimide film.
A popular structure of copper clad lamination used for FPC is three layer type consisting of a polyimide film, a copper foil, and an acrylic adhesive.
However, there are some problems pointed out for FPC; heat-resistance of FPC decreases more than the polyimide film because of that of adhesives, and the thickness of the FPC substrate is also restricted to the need of thickness due to that of the bonding layer.
「UPILEX VT」 can be bonded simply by heating (About 300℃) without the adhesive with ceramics and metal like copper, aluminum, stainless, etc.
The bonding pressure in this case is within a general range though differs according to the process and the material.
Of course, 「UPILEX VT」 has an enough characteristics as the polyimide film.
Excellent heat bonding property without losing the original film property was achieved by the further development of synthetic technology of the polyimide using BPDA.
「UPILEX VT」 is an aromatic groups polyimide as well as 「UPILEX-S」 and is able to be produced by the existing equipment for the polymerization and the casting without a special process.

Photo.1 The appearance of both film are similar.

UPILEX - S   UPILEX VT

3.Physical properties of 「UPILEX VT」

Heat bonding type polyimide film 「VT441S」 (30 μ m) was made for trial purposes.
The properties of films were compared about appearance, mechanical properties, thermal properties, electric properties, and chemical properties with those of 「UPILEX-S」 25 μ m of thickness .(catalogue value).
As a result, the properties of these film are quite similar to those of usual aromatic polyimide.

(1) Appearance of 「UPILEX VT」
「VT441S」 is abbreviated as VT and 「UPILEX-S」 is abbreviated as S.
VT is a transparent film of the polyimide color.
The appearance of VT is hardly distinguished to S.(Photo.1)

Table 1. Mechanical properties

Item	Unit	UPILEX VT VT(30μm)		UPILEX-S (25μm)		Test Method
Tensile Strength (MD)	kg/mm²	25℃	300℃	25℃	300℃	
Stress at 5% Elongation (MD)	kg/mm²	32	10	53	30	ASTM D882
Elongation (MD)	%	18	3	26	9	ASTM D882
Tensile Strength (MD)	kg/mm²	57	104	42	67	ASTM D882
Tensile Modulus (MD)	kg/mm²	620	110	930	380	ASTM D882
Tear Strength - Initiation [Graves] (MD)	kg/mm	21	—	23	—	ASTM D1004
Tear Strength - Propagation [Elmendorf] (MD)	g/mm	280	—	330	—	ASTM D1922

Fig.1 Tensile Stress – Strain Curves

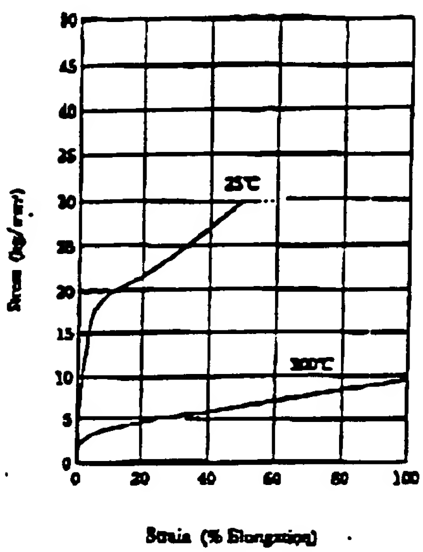
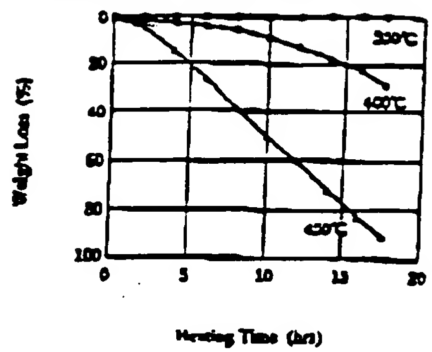


Fig.2 Isothermal Weight Loss(VT : 50μm)



(2) Mechanical properties of 「UPILEX VT」

A mechanical properties at 25℃ and 300℃ f VT are shown in Table 1.
Tensile strength at normal temperature is 32kg/mm² and the value at 300℃ is 10kg/mm².
The tensile modulus at normal temperature is about 70% of that of S, the elongation is 50-60%, which is larger than S.
Fig. 1 shows stress-strain curves at 25℃ and 300℃ of VT.
This figure says that VT is softer and larger drop of strength by heat than that of S.

(3) Thermal properties of 「UPILEX VT」

Table 2 shows a thermal properties of VT.
The level of the shrinkage rate at the high temperature of VT is similar to S.
The coefficient of thermal expansion of VT is about 20ppm which is larger than that of S.
Fig. 2 shows the weight loss properties by the pyrolysis of VT at the temperature of 350℃, 400℃, and 450℃.
The weight loss was hardly observed even after 18 hours at 350℃.

(4) Electric properties.

An electric properties of VT are shown in Table 3.
Each properties of VT are at similar level to S.

(5) Chemical properties.

Table 4 shows a chemical resistance of VT.
VT shows similar alkali resistance to S.
The dimension change of VT against various solvents is also very small.
It is said that the BPDA type polyimide has very high chemical resistance and VT also has the similar characteristics.
Although the general polyimide film has rather high water absorption, it appears that VT has comparatively small water absorption as well as S.

Table 2. Thermal properties

Item		UPILEX VT VT(50μm)	UPILEX S 25S(25μm)	Test Conditions (Test Method)
Heat Shrinkage (%)	MD	0.10	0.10	JIS C2318
200℃ 2Hours	TD	0.10	0.10	
Coefficient of thermal expansion	MD	18	12	20～200℃
(×ppm cm/cm/℃)	TD	21	12	At 5℃/min. temperature increse

Table 3. Electrical properties

Item	Unit	UPILEX VT [illegible] 25℃	UPILEX S 25S(25μm) [illegible]	[illegible]	Test Method
Dielectric Strength	kV/25μm	6.3	6.8	50HZ	ASTM D149
Dielectric Constant	–	3.2	3.5	1000HZ	ASTM D150
Dissipation Factor	–	0.0023	0.0013	1000HZ	ASTM D150
Volume Resistivity	Ω-cm	10E+17	10E+17	DC100V	ASTM D257
Surface Resistivity	Ω	>10E+17	>10E+17	DC100V	ASTM D257

Table 4. Chemical properties

Item / Retention rate after	[illegible] Strength	Elongation	Modulus	[illegible] Strength	Elongation	Modulus	Immersion Condition
10% Sodium Hydroxide	–	–	98%	80%	60%	95%	At 25℃ for 5 days
Water Absorption Rate		1.08%			1.00%		

(Dimensional Stability)	MD	TD	MD	TD (Unit%)	
(Chemicals)					
Ferric Chloride (37%)	+0.01	+0.01	–0.01	+0.01	At room temperature for 10 min.
5% Sodium Hydroxide	+0.02	+0.02	–0.02	+0.03	At 60℃ for 30 min.
Isopropanol	0.00	0.00	–0.00	+0.01	At room temperature for 10 min.
2N-Hydrochloric Acid	0.00	0.00	–0.00	–0.00	At room temperature for 10 min.

Fig.3 The retention rate of peel strength (%) VS Temperature

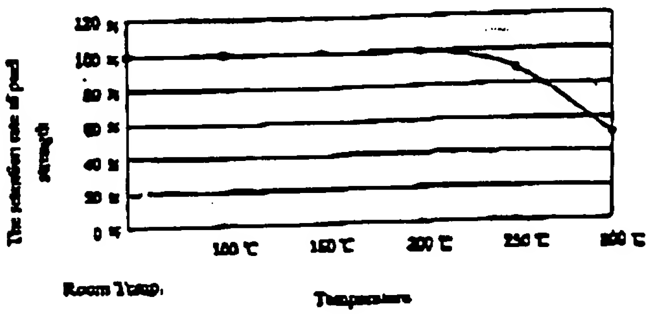
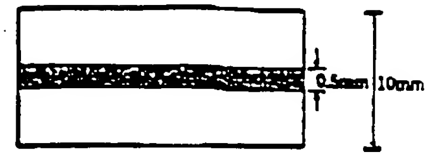
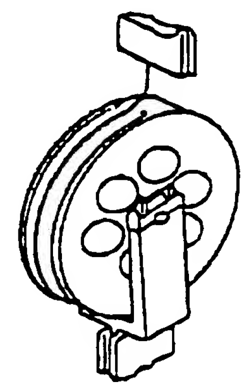


Fig.4 Test Specimen



The copper foil of 0.5mm width was left and other copper foil was removed by the etching.

Fig.5 90℃-Peel Test Gear



4.Heat bonding characteristic of「UPILEX VT」

The heat bonding test of VT/copper foil, VT/VT, and VT/S was made, and the peel strength of each case was measured.

(1) VT/copper foil

The test specimen was made by bonding VT and rolled copper foil (35 μm) by the heating roll.

The condition went by 300℃ in temperature and pressure 20-30kg/cm.

① Heat resistance

Fig. 3 showed the test result of peel strength in each temperature from normal temperature to 300℃.

Initial peel strength (T-Peel) was about 1.5-2kg/cm.

Initial peal strangth was maintained up to 200℃.

At 250℃, 90% of initial strength is maintained.

The retention rate has decreased even to 50% at 300℃.

② Chemical resistance

Fig. 4 shows the test specimen, which was prepared as follows; VT and copper foil of 10mm width was heat bonded then the copper foil of 0.5mm width was left and other copper foil was removed by the etching.

The test specimen was soaked in various chemicals for 60 minutes and peel strength before and after soaking was measured.

Peel strength was measured by 90°-Peel (Figure 5:IPC-TH-650).

Peel strength has not decreased by various chemicals as shown in Table 5.

③ Other experiments

Table 6 showed the condition of heat cycle test, solder heat-resistance test and pressure cooker test.

As the result, the retention rate of peel strength was 100% in the test of heat cycle and solder heat-resistant, but 90% in PCT.

(2)VT/VT

The heat bonding test of VT and VT was made.

The condition went by 330℃ in temperature, pressure 50-100kg/cm² and time for 60 minutes with a hot press.

Peal strength was 1kg/cm or more.

On the other hand, when a special method was used, heat bonding VT and VT at 300℃ with no pressure, was possible maintaining the peel strength of over 1 kg/cm.

(3)VT/S

VT and S were not able to be heat bonded in the same condition as VT/VT.

5. To the end

Besides the above-test,it was confirmed that VT can be heat bonded to the metal such as aluminum, stainless steel, and iron and to the ceramics.

Therefore, VT has great possibility to be used as a substitute of the field where the polyimide film was laminated using adhesive.

I wish to express my gratitude for cooperation by specialty materials dept.

Table 5. Chemical resistance of VT/copper foil

2N-HCl	100%	60min.
2N-NaOH	100%	60min.
MEK	100%	60min.
Toluene	100%	60min.

Table 6. Test condition of other experiments

Heat Cycle Test	150℃ × 30min. ―― -55℃ × 30min. (5times)
Solder Heat Resistance Test	280℃ × 10sec. 1N - HCl was used as flux
Pressure Cooker Test	121℃,2atm H_2O × 20hrs

UBE

UPILEX VT

Bonding Type Polyimide Film

UBE Industries, Ltd. has developed new BPDA type polyimide film "UPILEX VT".
UPILEX VT is a heat bonding type of polyimide film without using adhesive and applicable with various substrate material.

Features

(1) Heat bonding ability with ceramics, silicon wafers, and metals
(2) Bonding temperature : 300°C
(3) Excellent characteristics as polyimide film

Applications

- FPC
- HDD Suspention
- Ceramics Lamination
- Metal substrate PCB
- Sheet heater
- Micro Machine

Properties (30μm, MD)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Tensile Strength	25°C	ASTM D882	kg/mm²	32
	300°C			10
Elongation	25°C	ASTM D882	%	54
	300°C			74
Tensile Modulus	25°C	ASTM D882	kg/mm²	680
	300°C			180
Coefficient of Thermal Expansion	20～200°C	ASTM D233	ppm, °C-1	18
Heat Shrinkage	200°C, 2hr	JIS C2318	%	0.10
Dielectric Strength	25°C	ASTM D149	kV	7.5
Dielectric Constant	25°C, 1kHz	ASTM D150	–	3.2
Volume Resistivity	25°C	ASTM D257	Ω-cm	10^{17}
Chemical Resistance	Retention Rate of Modulus in 10% NAOH	-	%	~99

UBE INDUSTRIES,LTD. Specialty Products Division
Business Development Dept.
UBE Building. 3-11 Higashi-shinagawa 2-ch me, Shinagawa-ku, Tokyo 140, Japan

UBE INDUSTRIES, LTD

Heat Bonding Type Polyimide Film

UPILEX®-VT

]

UPILEX®-VT can be bonded simply heating (about 300°C) without the adhesive with various material.

Application

(1) FPC (Flexible Print Circuit)
(2) Metal sucstrate PCB
(3) HDD Suspension
(4) Sheet heater
(5) Ceramics lamination
(6) Micro Machine

Features

High bonding ability with ceramics, silicon waters, and metals.
Bonding temperature: 300°C
Enough characteristics as polyimide film.

Typical Properties

1. Mechanical Properties

Softer and larger drop of strength by heat than that of UPILEX®-S.

Table 1. Mechanical Properties

Item	Unit	UPILEX VT VT (30μm) 25 °C	 300°C	UPILEX-S 25S (25μm) 25°C	 300°C	Test Method
Tensile Strength	kg/mm^2	32	10	53	30	ASTM D882
Stress at 5 % elongation	kg/mm^2	20	4	26	9	ASTM D882
Elongation	%	54	74	42	67	ASTM D882
Tensile Modulus	kg/mm^2	680	180	930	380	ASTM D882
Tear Strength-Initiation [Graves]	kg/mm^2	16	-	23	-	ASTM D1004
Tear Strength-Propagation [Elmendorf]	g/mm	200	-	330	-	ASTM D1922

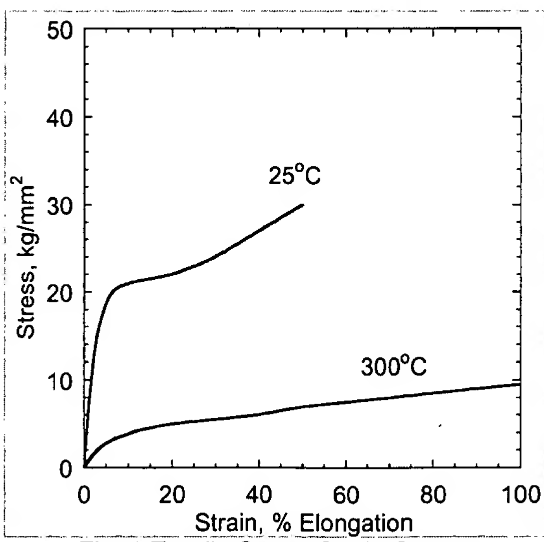


Fig. 1 Tensile Stress-Strain Curves

2. Electrical Properties

Similar level of each properties to UPILEX®-S.

Table 2. Electrical Properties

Item	Unit	UPILEX VT VT (30μm) 25 °C	UPILEX-S 25S (25μm) 25 °C	Test Conditions	Test Method
Dielectric Strength	KV/25μm	6.3	6.8	50 Hz	ASTM D149
Dielectric Constant	-	3.2	3.5	1000 Hz	ASTM D150
Dissipation Factor	-	0.0023	0.0013	1000 Hz	ASTM D150
Volume Resistivity	Ù-cm	10E+17	10E+17	DC100 V	ASTM D257
Surface Resistivity	Ù	> 10E+17	> 10E+17	DC100 V	ASTM D257

3. Thermal Properties

Similar level of the shrinkage rate at the high temperature to UPILEX®-S.
Larger coefficient of thermal expansion than that of UPILEX®-S.

Table 3. Thermal Properties

Item	Unit	UPILEX VT VT (30μm)	UPILEX-S 25S (25μm)	Test Conditions (Method)
Heat Shrinkage 200 °C 2 Hours	MD	0.10	0.10	JIS C2318
	TD	0.10	0.10	
Coefficient of thermal expansion (× ppm cm/cm/°C)	MD	18	12	20 ~ 200 °C
	TD	21	12	At 5 °C/min. temperature increase

*MD=Machine Direction
TD=Transverse Direction

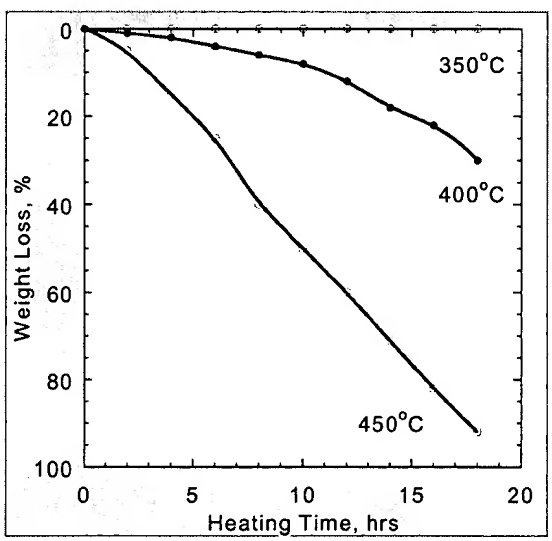


Fig. 2 Isothermal Weighte Loss (VT: 30 μm)

4. Chemical-Resistance Properties

Similar alkali resistance to UPILEX®-S.
Small dimension change against various solvents.
High chemical resistance.
Comparatively small water absorption as well as UPILEX®-S.
No decrease of peel strength by various chemicals.

Table 4. Chemical Properties

Item		UPILEX VT		UPILEX-S		Immersion
Retention of =		VT (30μm)		25S (25μm)		Condition
10 % Sodium Hydroxide	Strength	-		80 %		At 25 °C for 5 days
	Elongation	-		60 %		
	Modulus	98 %		95 %		
Water Absorption Rate		1.08 %		1.00 %		
Dimensional Stability		MD	TD	MD	TD	
Ferric Chloride		+0.01	+0.01	-0.01	+0.01	At R.T. for 10 min.
5% Sodium Hydroxide		+0.02	+0.02	-0.01	+0.03	At 60 °C for 30 min.
Isopropanol		0.00	0.00	-0.00	+0.01	At R.T. for 10 min.
2N-Hydrichloric Acid		0.00	0.00	-0.00	-0.00	At R.T. for 10 min.

Table 5. Chemical Resistance of VT/Copper Foil

Chemical	The Retention Rate of Peel Strength.	Immersion Time
2N-HCl	100 %	60 min.
2N-NaOH	100 %	60 min.
MEK	100 %	60 min.
Toluene	100 %	60 min.

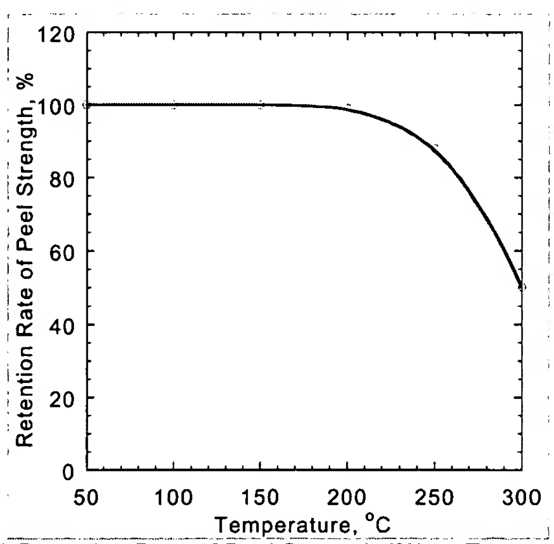


Fig. 3 Retention Rate of Peel Strength (%) vs Temperature

5. Oth r F atures

High retention rate of peel strength in the test of heat cycle, solder heat-resistance and PCT.

Table 6. Retention Rate Test Condition of Other Experiments and Results

Heat Cycle Test	150 °C × 30 min. ~ -55 °C × 30 min. (5 times)	100 %
Solder Heat Resistance Test	280 °C × 10 sec. 1N-HCl was used at flux	100 %
Pressure Cooker Test	121 °C, 2 atm H_2O × 20 hrs	90 %

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